(Submitted in June of 2005 for the 8th U.S. National Conference on Earthquake Engineering.)

Effects of Earthquake Record Scaling on Nonlinear Structural Response

Nicolas Luco[1], and Paolo Bazzurro[2]

[1]AIR Worldwide Corporation (now with U.S. Geological Survey), [2]AIR Worldwide Corporation

ABSTRACT

Limitations in the existing ground motion database force the scaling of real records in order to obtain accelerograms that are consistent with the ground motion target for structural design and evaluation. This study investigates whether scaling of a record randomly selected from a M-R (earthquake magnitude and source-to-site distance) bin introduces bias in nonlinear structural response. The records are scaled up and down by large factors to determine when/if the response to scaled records departs from the response of un-scaled ones that are "naturally" at the target level. The nonlinear response of a suite of single-degree-of freedom (SDOF) systems with multiple periods and strengths is investigated. Also considered are elastic and ductile models of a multi-degree-of-freedom (MDOF) building.

The results of this study demonstrate that scaling earthquake records can, in fact, introduce a bias in the nonlinear structural drift response. The extent of bias depends on the period of vibration and overall strength of the structure of interest, and whether its drift response is dominated by excitation input at a single or multiple periods (i.e., SDOF versus MDOF structures). The severity of the bias also depends on the characteristics (e.g., M and R) of the records that are scaled, as well as those of the target ground motion scenario. For the most part, the bias can be explained by systematic differences between the elastic response spectra for records that are scaled up (or down) and those that are naturally (without scaling) at a target spectral acceleration level.